BISS Biodiversity Information Science and Standards

Biodiversity Information Science and Standards 10: e183778
doi: 10.3897/biss.10.183778

OPEN ACCESS

Conference Abstract

ForestWeb3: Mobilising, Harmonising and Incentivising Forest Biodiversity and Environmental Monitoring Data through Web 3.0 Technology

Robert John Lewis[‡], Jonas Lembrechts[§], Peter Walker[|], Chunli Li[¶], Sigrid Engen[#]

‡ Norwegian Institue for Nature Research, Bergen, Norway
§ University of Antwerp, Antwerp, Belgium
| Stockholm Environment Institute, Tallinn, Estonia
¶ University of Bergen, Bergen, Norway
# Norwegian Institue for Nature Research, Tromso, Norway

Corresponding author: Robert John Lewis (robert.lewis@nina.no)

Received: 29 Dec 2025 | Published: 29 Dec 2025

Citation: Lewis R, Lembrechts J, Walker P, Li C, Engen S (2025) ForestWeb3: Mobilising, Harmonising and Incentivising Forest Biodiversity and Environmental Monitoring Data through Web 3.0 Technology. Biodiversity Information Science and Standards 10: e183778. https://doi.org/10.3897/biss.10.183778

Abstract

Background and Rationale

Despite decades of progress in ecological monitoring, primary biodiversity and environmental data remain unevenly mobilised and poorly interoperable (Hampton et al. 2015, Poisot et al. 2019). Datasets, often gathered with public funds, frequently remain inaccessible or insufficiently described, limiting their reuse in global syntheses (Culina et al. 2018). Ecologists' concerns about trust, transparency, and control of shared data persist, particularly where data production is resource-intensive or socially embedded. These concerns echo the foundational properties of distributed ledgers, where ownership and governance are distributed across peer networks rather than centralized repositories (Lewis et al. 2023).

Forests exemplify both the potential and the challenge of such decentralised infrastructures. As globally significant carbon and biodiversity reservoirs, forests are also

© Lewis R et al. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

deeply fragmented across ownership and jurisdictional boundaries. In Europe alone, over half of forested land is privately owned, yet these actors often lack mechanisms to derive tangible value from stewardship. At the same time, digital twins (macroecological models) that integrate in situ and remotely sensed data, are becoming central to forest policy and monitoring frameworks (e.g., Food and Agriculture Organization of the United Nations (FAO), Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), Global Biodiversity Framework (GBF)). ForestWeb3 (FW3) hypothesizes that a decentralised, Findable Accessible, Interoperable, Reusable (FAIR; Wilkinson et al. 2016, Nosek et al. 2022)-aligned data network can unlock the latent value of underused biodiversity data while building trust and incentives for participation..

Objectives

Mobilisation and harmonisation of forest biodiversity and environmental data (Objective 1): to spearhead a shift from data curation to data stewardship through a decentralised data infrastructure built on open-source blockchain frameworks.

Incentivisation and uptake (Objective 2): to design transnational pathways through which private forest owners and local communities can be economically rewarded for verifiable ecological data via nature-backed digital assets and ReFi mechanisms.

Together, these objectives align technical innovation (Objective 1) with behavioural and economic motivation (Objective 2), establishing the groundwork for distributed biodiversity observatories capable of sustaining long-term ecological data flows.

Methodological Approach

WP 1 develops a blockchain-based data ledger with smart contracts that autonomously manage data registration, access control, and reuse. Metadata and identifiers are immutably recorded on-chain, while primary datasets remain decentralised on contributor-managed nodes. This architecture enables contributors to retain data sovereignty while ensuring transparency and traceability in reuse transactions.

WP 2 extends the infrastructure to real-time environmental sensing through the integration of modular Internet ofThings (loiT)-based microclimate sensors. These devices stream environmental data at high temporal resolution directly into the distributed ledger, forming a Decentralized Physical Infrastructure Network (DePIN) for ecological data.

WP 3 links these data streams to the creation of digital twins of forest ecosystems, combining in situ biodiversity observations with satellite and climate datasets to model ecosystem integrity. These models underpin the valuation of nature-backed digital assets, a form of tokenised evidence for ecological performance, providing the data foundation for voluntary biodiversity and carbon markets.

Finally, WP4 investigates forest owners' perceptions, motivations, and barriers to adopting regenerative finance (ReFi)-based conservation mechanisms. Through

interviews and a pan-European survey, it explores how varying sociocultural and institutional contexts shape engagement with emerging biodiversity credit schemes, drawing parallels to established Payment for Ecosystem Services frameworks (Kaiser et al. 2021).

Significance and Legacy

FW3 exemplifies the convergence of data decentralisation, digital sensing, and regenerative economics, a triad capable of transforming how ecological knowledge is produced, verified, and valued. By embedding data provenance and attribution within the infrastructure itself, we addresses long-standing issues of trust and recognition in ecological data sharing. Its incentive mechanisms offer pathways to decouple conservation finance from traditional public funding, potentially scaling stewardship and democratizing data mobilisation across millions of hectares of privately owned forest land.

The project's legacy lies in demonstrating that data infrastructures can be both scientific and economic commons, capable of sustaining biodiversity monitoring through distributed participation. Beyond its immediate technical deliverables, ForestWeb3 contributes to a broader vision of dynamic, self-sustaining ecological data ecosystems that power both global biodiversity frameworks and locally grounded conservation action.

Keywords

forests, blockchain, regenerative finance, environmental stewardship

Presenting author

Robert John Lewis

Presented at

Living Data 2025

Funding program

Biodiversity Monitoring joint call, co-funded by the European Commission (GA No. 101052342) and The Research Council of Norway, The Research Foundation Flanders and The Estonian Research Council.

Grant title

Forest-Web-3.0

Hosting institution

Norewgian Institute for Nature Research (NINA)

Conflicts of interest

The authors have declared that no competing interests exist.

References

- Culina A, Baglioni M, Crowther TW, et al. (2018) Navigating the unfolding open data landscape in ecology and evolution. Nature Ecology & Evolution 2 (3): 420-426. https://doi.org/10.1038/s41559-017-0458-2
- Hampton S, Anderson S, Bagby S, et al. (2015) The Tao of open science for ecology. Ecosphere 6 (7): 1-13. https://doi.org/10.1890/es14-00402.1
- Kaiser J, Haase D, Krueger T, et al. (2021) Payments for ecosystem services: a review of definitions, the role of spatial scales, and critique. Ecology and Society 26 (2). https://doi.org/10.5751/es-12307-260212
- Lewis RJ, Marstein K, Grytnes J (2023) Incentivising open ecological data using blockchain technology. Scientific Data 10 (1). https://doi.org/10.1038/s41597-023-02496-2
- Nosek B, Hardwicke T, Moshontz H, et al. (2022) Replicability, Robustness, and Reproducibility in Psychological Science. Annual Review of Psychology 73 (1): 719-748. https://doi.org/10.1146/annurev-psych-020821-114157
- Poisot T, Bruneau A, Gonzalez A, et al. (2019) Ecological Data Should Not Be So Hard to Find and Reuse. Trends in Ecology & Evolution 34 (6): 494-496. https://doi.org/10.1016/j.tree.2019.04.005
- Wilkinson M, Dumontier M, Aalbersberg I, et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3 (1). https://doi.org/10.1038/sdata.2016.18